not very vehement opponents of transmutation. We might have anticipated a contrary leaning on the part of both, for to what does the theory of progression point? It supposes a gradual elevation in grade of the vertebrate type, in the course of ages, from the most simple ichthyic form to that of the placental mammalia and the coming upon the stage last in the order of time of the most anthropomorphous mammalia, followed by the human race—this last thus appearing as an integral part of the same continuous series of acts of development, one link in the same chain, the crowning operation as it were of one and the same series of manifestations of creative power. If the dangers apprehended from transmutation arise from the too intimate connection which it tends to establish between the human and merely animal natures, it might have been expected that the progressive development of organisation, instinct, and intelligence might have been unpopular, as likely to pioneer the way for the reception of the less favoured doctrine. But the true explanation of the seeming anomaly is this, that no one can believe in transmutation who is not profoundly convinced that all we know in palæontology is as nothing compared with what we have yet to learn, and they who regard the record as so fragmentary, and our acquaintance with the fragments which are extant as so rudimentary, are apt to be astounded at the confidence placed by the progressionists in data which must be defective in the extreme. But exactly in proportion as the completeness of the record and our knowledge of it are overrated, in that same degree are many progressionists unconscious of the goal towards which they are drifting. Their faith in the fullness of the annals leads them to regard all breaks in the series of organic existence, or in the sequence of the fossiliferous rocks, as proofs of original chasms and leaps in the course of nature,—signs of the intermittent action of the creational force, or of catastrophes which

devastated the habitable surface. They do not doubt that there is a continuity of plan, but they believe that it exists in the Divine mind alone, and they are therefore without apprehension that any facts will be discovered which would imply a material connection between the outgoing organisms and the incoming ones.

CHAPTER XXI.

ON THE ORIGIN OF SPECIES BY VARIATION AND NATURAL SELECTION.

MR. DARWIN'S THEORY OF THE ORIGIN OF SPECIES BY NATURAL SELECTION—MEMOIR BY MR. WALLACE—MANNER IN WHICH FAVOURED RACES PREVAIL IN THE STRUGGLE FOR EXISTENCE—FORMATION OF NEW RACES BY BREEDING—HYPOTHESES OF DEFINITE AND INDEFINITE MODIFIABILITY EQUALLY ARBITRARY—COMPETITION AND EXTINCTION OF RACES—PROGRESSION NOT A NECESSARY ACCOMPANIMENT OF VARIATION—DISTINCT CLASSES OF PHENOMENA WHICH NATURAL SELECTION EXPLAINS—UNITY OF TYPE, RUDIMENTARY ORGANS, GEOGRAPHICAL DISTRIBUTION, RELATION OF THE EXTINCT TO THE LIVING FAUNA AND FLORA, AND MUTUAL RELATIONS OF SUCCESSIVE GROUPS OF FOSSIL FORMS—LIGHT THROWN ON EMBRYOLOGICAL DEVELOPMENT BY NATURAL SELECTION—WHY LARGE GENERA HAVE MORE VARIABLE SPECIES THAN SMALL ONES—DR. HOOKER ON THE EVIDENCE AFFORDED BY THE VEGETABLE KINGDOM IN FAVOUR OF CREATION BY VARIATION—STEENSTRUP ON ALTERNATE GENERATION—HOW FAR THE DOCTRINE OF INDEPENDENT CREATION IS OPPOSED TO THE LAWS NOW GOVERNING THE MIGRATION OF SPECIES.

FOR many years after the promulgation of Lamarck's doctrine of progressive development, geologists were much occupied with the question whether the past changes in the animate and inanimate world were brought about by sudden and paroxysmal action, or gradually and continuously, by causes differing neither in kind nor degree from those now in operation.

An anonymous author published in 1844 'The Vestiges of Creation,' a treatise, written in a clear and attractive style, which made the English public familiar with the leading views of Lamarck on transmutation and progression, but brought no new facts or original line of argument to

support those views, or to combat the principal objections which the scientific world entertained against them.

No decided step in this direction was made until the publication in 1858 of two papers, one by Mr. Darwin and another by Mr. Wallace, followed in 1859 by Mr. Darwin's celebrated work on 'The Origin of Species by Means of Natural Selection; or, the Preservation of favoured Races in the Struggle for Life.' The author of this treatise had for twenty previous years strongly inclined to believe that variation and the ordinary laws of reproduction were among the secondary causes always employed by the Author of Nature, in the introduction from time to time of new species into the world, and he had devoted himself patiently to the collecting of facts, and making of experiments in zoology and botany, with a view of testing the soundness of the theory of transmutation. Part of the MS. of his projected work was read to Dr. Hooker as early as 1844, and some of the principal results were communicated to me on several occasions. Dr. Hooker and I had repeatedly urged him to publish without delay, but in vain, as he was always unwilling to interrupt the course of his investigations; until at length Mr. Alfred R. Wallace, who had been engaged for years in collecting and studying the animals of the East Indian archipelago, thought out, independently for himself, one of the most novel and important of Mr. Darwin's theories. This he embodied in an essay 'On the Tendency of Varieties to depart indefinitely from the original Type.' It was written at Ternate, in February 1858, and sent to Mr. Darwin, with a request that it might be shown to me if thought sufficiently novel and interesting. Dr. Hooker and I were of opinion that it should be immediately printed, and we succeeded in persuading Mr. Darwin to allow one of the MS. chapters of is 'Origin of Species,' entitled 'On the Tendency of Species to form Varieties, and on the Perpetuation of Species and

Varieties by natural Means of Selection,' to appear at the same time.*

By reference to these memoirs it will be seen that both writers begin by applying to the animal and vegetable worlds the Malthusian doctrine of population, or its tendency to increase in a geometrical ratio, while food can only be made to augment even locally in an arithmetical one. There being, therefore, no room or means of subsistence for a large proportion of the plants and animals which are born into the world, a great number must annually perish. Hence there is a constant struggle for existence among the individuals which represent each species, and the vast majority can never reach the adult state, to say nothing of the multitudes of ova and seeds, which are never hatched or allowed to germinate. Of birds it is estimated that the number of those which die every year equals the aggregate number by which the species to which they respectively belong is on the average permanently represented.

The trial of strength, which must decide what individuals are to survive and what to succumb, occurs in the season when the means of subsistence are fewest, or enemies most numerous, or when the individuals are enfeebled by climate or other causes; and it is then that those varieties which have any, even the slightest, advantage over others come off victorious. They may often owe their safety to what would seem to a casual observer a trifling difference, such as a darker or lighter shade of colour rendering them less visible to a species which preys upon them, or sometimes to attributes more obviously advantageous, such as greater cunning, or superior powers of flight or swiftness of foot. These peculiar qualities and faculties, bodily and instinctive, may enable them to outlive their less favoured rivals, and being trans-

* See Proceedings of Linnæan Society, 1858.

mitted by the force of inheritance to their offspring, will constitute new races, or what Mr. Darwin calls 'incipient species.' If one variety, being in other respects just equal to its competitors, happens to be more prolific, some of its offspring will stand a greater chance of being among those which will escape destruction, and their descendants, being in like manner very fertile, will continue to multiply at the expense of all less prolific varieties.

As breeders of domestic animals, when they choose certain varieties in preference to others to breed from, speak technically of their method as that of 'selecting,' Mr. Darwin calls the combination of natural causes, which may enable certain varieties of wild animals or plants to prevail over others of the same species, 'natural selection.'

A breeder finds that a new race of cattle with short horns or without horns may be formed, in the course of several generations, by choosing varieties having the most stunted horns as his stock from which to breed; so nature, by altering, in the course of ages, the conditions of life, the geographical features of a country, its climate, the associated plants and animals, and, consequently, the food and enemies of a species and its mode of life, may be said, by this means, to select certain varieties best adapted for the new state of things. Such new races may often supplant the original type from which they have diverged, although that type may have been perpetuated without modification for countless anterior ages in the same region, so long as it was in harmony with the surrounding conditions then prevailing.

Lamarck, when speculating on the origin of the long neck of the giraffe, imagined that quadruped to have stretched himself up in order to reach the boughs of lofty trees, until by continued efforts, and longing to reach higher, he obtained an elongated neck. Mr. Darwin and Mr. Wallace simply suppose that, in a season of scarcity, the longer-necked indi-

viduals, having the advantage in this respect over the rest of the herd, as being able to browse on foliage out of their reach, survived them, and transmitted their peculiarity of cervical conformation to their successors.

By the multiplying of slight modifications in the course of thousands of generations, and by the handing down of the newly-acquired peculiarities by inheritance, a greater and greater divergence from the original standard is supposed to be effected, until what may be called a new species, or, in a greater lapse of time, a new genus, will be the result.

Every naturalist admits that there is a general tendency in animals and plants to vary; but it is usually taken for granted, though we have no means of proving the assumption to be true, that there are certain limits beyond which each species cannot pass under any circumstances, or in any number of generations. Mr. Darwin and Mr. Wallace say that the opposite hypothesis, which assumes that every species is capable of varying indefinitely from its original type, is not a whit more arbitrary, and has this manifest claim to be preferred, that it will account for a multitude of phenomena which the ordinary theory is incapable of explaining.

We have no right, they say, to assume, should we find that a variable species can no longer be made to vary in a certain direction, that it has reached the utmost limit to which it might, under more favourable conditions, or if more time were allowed, be made to diverge from the parent type, and this view is supported by the fact, that our oldest domestic animals and cultivated plants, those which have varied most widely from the original parent stock, still continue to produce new varieties and show no sign whatever of ceasing to vary.

Hybridisation is not considered by Mr. Darwin as a cause of new species, but rather as tending to keep variation within bounds. Varieties which are nearly allied cross readily

with each other, and with the parent stock, and such crossing tends to keep the species true to its type, while forms which are less nearly related, although they may intermarry, produce no mule offspring capable of perpetuating their kind.

The competition of races and species, observes Mr. Darwin, is always most severe between those which are most closely allied and which fill nearly the same place in the economy of nature. Hence, when the conditions of existence are modified, the original stock runs great risk of being superseded by some one of its modified offshoots. The new race or species may not be absolutely superior in the sum of its powers and endowments to the parent stock, and may even be more simple in structure and of a lower grade of intelligence, as well as of organisation, provided, on the whole, it happens to have some slight advantage over its rivals. Progression, therefore, is not a necessary accompaniment of variation and natural selection, though, when a higher organisation happens to be coincident with superior fitness to new conditions, the new species will have greater power and a greater chance of permanently maintaining and extending its ground. One of the principal claims of Mr. Darwin's theory to acceptance is, that it enables us to dispense with a law of progression as a necessary accompaniment of variation. It will account equally well for what is called degradation, or a retrograde movement towards a simpler structure, and does not require Lamarck's continual creation of monads; for this was a necessary part of his system, in order to explain how, after the progressive power had been at work for myriads of ages, there were as many beings of the simplest structure in existence as ever.

Mr. Darwin argues, and with no small success, that all true classification in zoology and botany is, in fact, genealogical, and that community of descent is the hidden bond which naturalists have been unconsciously seeking,

while they often imagined that they were looking for some unknown plan of creation.

As the 'Origin of Species'* is in itself a condensed abstract of a much larger work not yet published, I could not easily give an analysis of its contents within narrower limits than those of the original, but it may be useful to enumerate briefly some of the principal classes of phenomena on which the theory of 'Natural Selection' would throw light.

In the first place, it would explain, says Mr. Darwin, the unity of type which runs through the whole organic world, and why there is sometimes a fundamental agreement in structure in the same class of beings which is quite independent of their habits of life, for such structure, derived by inheritance from a remote progenitor, has been modified, in the course of ages, in different ways, according to the conditions of existence. It would also explain why all living and extinct beings are united, by complex radiating and circuitous lines of affinity with one another, into one grand system;† also, there having been a continued extinction of old races and species in progress, and a formation of new ones by variation, why in some genera which are largely represented, or to which a great many species belong, many of these are closely but unequally related; also, why there are distinct geographical provinces of species of animals and plants, for, after long isolation by physical barriers, each fauna and flora, by varying continually, must become distinct from its ancestral type, and from the new forms assumed by other descendants which have diverged from the same stock.

The theory of indefinite modification would also explain why rudimentary organs are so useful in classification, being the remnants preserved by inheritance of organs which the

* Origin of Species, 6th ed. Introduction, p. 1.
† Ibid. p. 417.

ancestors of the present species once used—as in the case of the rudiments of eyes in insects and reptiles inhabiting dark caverns, or of the wings of birds and beetles which have lost all power of flight. In such cases the affinities of species are often more readily discerned by reference to these imperfect structures than by others of much more physiological importance to the individuals themselves.

The same hypothesis would explain why there are no mammalia in islands far from continents, except bats, which can reach them by flying; and also why the birds, insects, plants, and other inhabitants of islands, even when specifically unlike, usually agree generically with those of the nearest continent, it being assumed that the original stock of such species came by migration from the nearest land.

Variation and natural selection would also afford a key to a multitude of geological facts otherwise wholly unaccounted for, as, for example, why there is generally an intimate connection between the living animals and plants of each great division of the globe and the extinct fauna and flora of the post-tertiary or tertiary formations of the same region; as, for example, in North America, where we not only find among the living mollusca peculiar forms foreign to Europe, such as Gnathodon and Fulgar (a subgenus of Fusus), but meet also with extinct species of those same genera in the tertiary fauna of the same part of the world. In like manner, among the mammalia we find in Australia not only living kangaroos and wombats, but fossil individuals of extinct species of the same genera. So also there are recent and fossil sloths, armadilloes, and other edentata in South America, and living and extinct species of elephant, rhinoceros, tiger, and bear in the great Europeo-Asiatic continent. The theory of the origin of new species by variation will also explain why a species which has once died out never reappears, and why the fossil fauna and flora recede farther and farther from the living type in propor-